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ORIGINAL ARTICLE – RECONSTRUCTIVE ONCOLOGY

Regional Market Competition and the Use of Immediate Breast Reconstruction After Mastectomy

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ABSTRACT

Background. Prior work has shown that the competitiveness of the market in which hospitals operate is associated with use of surgical procedures. This study examined the association between regional market competition and use of breast reconstruction for women with breast cancer and ductal carcinoma in situ undergoing mastectomy.

Methods. Women who underwent mastectomy from 2010 to 2011 recorded in the National Inpatient Sample were selected. The competitive market environment for each hospital in which patients were treated was estimated using the Herfindahl–Hirschman Index. Multivariable models were developed to examine the association between regional market competition and breast reconstruction, with adjustment for other clinical, demographic, and structural variables.

Results. Immediate breast reconstruction was performed for 9902 (45%) of 22,011 women. The rate of immediate breast reconstruction was 34.5% at hospitals in non-competitive markets, 49% at hospitals in moderately competitive markets, and 56.4% at hospitals in highly competitive markets ($P < 0.0001$). In a multivariable model, women in moderately competitive markets were 24% (risk ratio [RR] 1.24; 95% confidence interval [CI] 1.10–1.41) more likely to undergo immediate breast reconstruction than women in noncompetitive markets, whereas those in competitive markets were 25% (RR 1.25; 95% CI 1.11–1.41) more likely to have reconstruction. Later year of treatment, higher census tract income level, and residence in an urban area were associated with an increased likelihood of reconstruction ($P < 0.05$ for all). In contrast, older age, non-white race, and non-commercial insurance were associated with a lower likelihood of reconstruction ($P < 0.05$ for all).

Conclusion. Patients who undergo mastectomy at hospitals in competitive markets are more likely to undergo immediate breast reconstruction.

For women undergoing mastectomy, immediate breast reconstruction offers a number of short- and long-term psychological benefits including improved self-esteem and body image and decreased levels of anxiety and depression.[1–4] Based on these benefits, it is recommended that women should be counseled about the benefits of reconstruction before undergoing mastectomy.[5] These guidelines apply to women with invasive breast cancer undergoing mastectomy as well as to those with ductal carcinoma in situ (DCIS).

Despite the benefits of immediate breast reconstruction, studies have shown that the procedure is consistently underused.[6–8] Among women with breast cancer who underwent mastectomy, the rate of reconstruction was only 27% in 2005 but rose steeply to 43% by 2014.[6] Access to breast reconstruction remains a challenge, with minority women and those with low socioeconomic status having particularly low rates of reconstruction.

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In addition to clinical and demographic factors, there is growing recognition that the contextual environment in which a patient receives care influences the type of care rendered.[9–11] A hospital's underlying financial status as well as the competitive market forces in which hospitals operate are two such factors.[9–12] Hospitals located in competitive market environments are more likely to offer technologically advanced and specialized treatments, sometimes including interventions that have not demonstrated efficacy.[9–11] The desire to increase market share is a likely factor in a hospital's decision to offer such treatments.

Because the availability and use of immediate breast reconstruction may be one factor influencing patients' decision on where to undergo mastectomy, we hypothesized that hospitals located in competitive market environments would be more likely to offer immediate breast reconstruction, as women may be more likely to seek out breast cancer surgery at institutions in which reconstructive surgeons are also available. This study aimed to examine the association between regional market competition and the use of breast reconstruction for women with breast cancer or DCIS undergoing mastectomy.

METHODS

Data Sources and Cohort

We used data from the National (Nationwide) Inpatient Sample (NIS) to identify women who underwent mastectomy. The NIS is a discharge database that captures a random sample comprising 20% of hospital discharges in the United States. In 2010, the NIS included data on approximately 8 million hospital stays from 45 states.[13] Data on regional market competition were ascertained from the Hospital Market Structure (HMS) file, which we linked to the NIS.[14,15] The HMS file includes data describing market competition that are updated every 3 years. Therefore, we used the data from 2009 and excluded the unlinked hospitals.

We selected women 18–90 years of age who underwent a mastectomy for invasive breast cancer or DCIS in 2010 and 2011 (Fig. 1, Table S1). Patients who had a secondary malignancy to the breast were excluded from the study.

Competitiveness Measures

We used the Herfindahl–Hirschman Index (HHI) to measure hospital competition. The HHI, a commonly accepted measure of market concentration,[16–18] is calculated by summing the squared market shares of each hospital competing in the market and multiplying by 10,000. It is generally classified into the following four categories: lower than 100 (highly competitive), 100–1500 (unconcentrated markets, competitive), 1500–2500 (moderately concentrated), and higher than 2500 (highly concentrated markets, noncompetitive).[18] Because few hospitals have an HHI lower than 100, similar to prior work, we classified hospitals with an HHI lower than 1500 as competitive markets.[9]

In the HMS file, a market can be defined by an area enclosed by a variable or fixed radius centered on the hospital, by patient flow, or by geopolitical boundaries. Each hospital's market share is calculated as its number of discharges divided by the total number of discharges from all hospitals in the market. As our primary measure of competition, we used the HHI with a variable radius

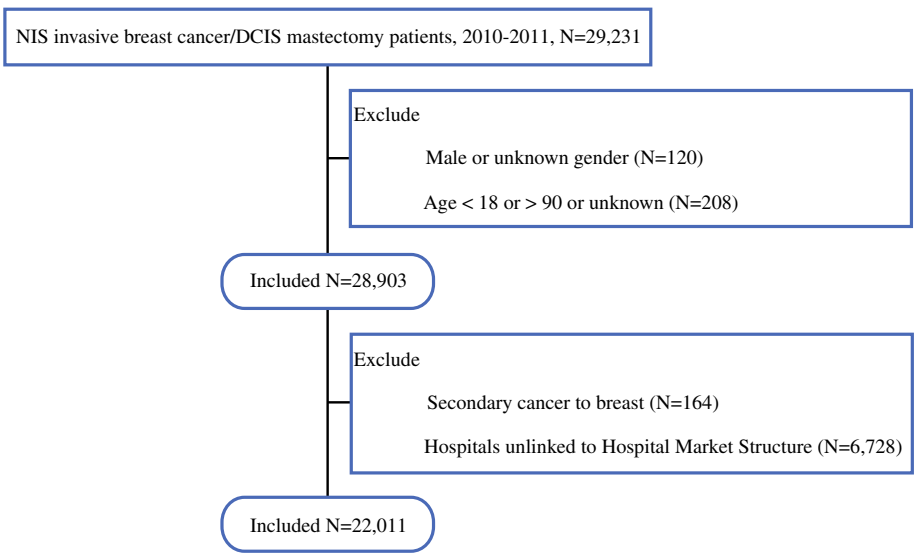

FIG. 1 Flowchart of cohort selection

definition that captures 75% of the hospital's discharges (radius 75% HHI).

We performed additional sensitivity analyses using HHI defined by a 90% variable radius (capturing 90% of discharges), a fixed radius (15 miles), patient flow (collection of patients' zip codes that accounts for 75, 90 or 95% of a hospital's discharge), and geopolitical boundaries based on Metropolitan Statistical Areas (MSA), Health Service Areas (HSA), and Core-Based Statistical Areas (CBSA) and counties.

Patient and Hospital Characteristics

Patients were categorized based on receipt of immediate breast reconstructive surgery (flap or implant/tissue expander). The types of mastectomy (radical, simple, skin sparing) and performance of axillary lymph node dissection (ALND) also were noted (Table S1). The demographic characteristics analyzed included year (2010–2011), age (< 40, 40–49, 50–59, 60–69, 70–79, ≥ 80 years), race/ethnicity (white, black, Hispanic, other/unknown), income status (low, $<$ \$39,000; medium–low, \$39,000–\$47,999; medium–high, \$48,000–\$62,999; high, \$63,000 +, unknown), insurance status (Medicare, Medicaid, private, self-pay, other/unknown), and type of admission (urgent, elective, unknown).

Comorbidity was measured using the Elixhauser Comorbidity Index classified as 0, 1, or 2 and higher. The hospitals were characterized by region (Northeast, Midwest, South, West), teaching status (teaching, non-teaching, unknown), bed size (small, medium, large, unknown), and location (rural, urban, unknown).

Statistical Analysis

Frequency distributions of patient and hospital characteristics were compared using Chi square tests based on receipt of immediate breast reconstruction. We used a mixed-effect log-Poisson regression model to evaluate the association between demographic characteristics and immediate breast reconstruction. The model included radius 75% HHI, breast cancer, mastectomy, axillary lymph node dissection, year, age, race/ethnicity, income and insurance status, type of admission, comorbidity, hospital region, bed size, and location. Hospitals were included as a random intercept to account for hospital-level clustering. Patients from hospitals with unknown bed size and location were excluded from the models because of multicollinearity. Similar models were developed to examine the sensitivity for different HHI measures, with adjustment for the same set of demographic variables. All analyses were performed with SAS version 9.4 (SAS Institute Inc, Cary, NC, USA). All statistical tests were two-sided, and a P value lower than 0.05 was considered statistically significant.

RESULTS

Among 22,011 women, immediate breast reconstruction was performed for 9902 women (45%), whereas 12,109 women (55%) did not undergo reconstruction. The rate of immediate reconstruction was 41.8% among women with invasive breast cancer and 64.4% among those with DCIS ($P < 0.0001$) (Table 1). Performance of immediate breast reconstruction rose from 41.5% in 2010 to 48.2% in 2011 ($P < 0.0001$).

In the unadjusted analysis, the rate of immediate breast reconstruction was 34.5% at hospitals in non-competitive markets, 49% at facilities in moderately competitive markets, and 56.4% in highly competitive markets ($P < 0.0001$). In a multivariable model, treatment at a hospital in a competitive regional market was associated with an increased likelihood of immediate breast reconstruction (Table 2). Women treated in moderately competitive markets were 24% (risk ratio [RR], 1.24; 95% confidence interval [CI], 1.10–1.41) more likely to undergo immediate breast reconstruction than women treated at hospitals in a non-competitive market, whereas those treated in competitive markets were 25% (RR 1.25; 95% CI 1.11–1.41). more likely to have reconstruction.

Women with DCIS were 20% (RR 1.20; 95% CI 1.14–1.26) more likely to undergo immediate reconstruction than those with invasive cancer (Fig. 2). Later year of treatment, higher census tract income level, and residence in an urban area also were associated with an increased likelihood of immediate reconstruction ($P < 0.05$ for all). In contrast, older age, non-white race, and non-commercial insurance were associated with a lower likelihood of immediate breast reconstruction ($P < 0.05$ for all).

These findings were robust in a number of sensitivity analyses (Tables S2 and S3). When a 90% radius was used to define regional markets, the risk ratio for immediate reconstruction in competitive markets versus non-competitive markets was 1.39 (95% CI 1.23–1.57). Similarly, using a fixed-radius definition of competition, the risk ratio for immediate reconstruction in a competitive market was 1.21 (95% CI 1.06–1.38). In contrast, competition was not significantly associated with immediate breast reconstruction when patient flow was used as a metric for hospital competition.

TABLE 1 Demographic characteristics of patients and hospitals

	Immediate breast reconstruction				*P* value
	No		Yes		
	n	%	*n*	%	
All	12,109	55.0	9902	45.0	
Breast cancer					< 0.001
Invasive breast cancer	11,002	58.2	7896	41.8	
DCIS	1107	35.6	2006	64.4	
Mastectomy					< 0.001
Radical	258	60.3	170	39.7	
Simple	11,718	60.4	7680	39.6	
Skin-sparing	133	6.1	2052	93.9	
Axillary lymph node evaluation					< 0.001
No	2555	44.4	3205	55.6	
Yes	9554	58.8	6697	41.2	
Year					
2010	6156	58.5	4370	41.5	
2011	5953	51.8	5532	48.2	
Age (years)					< 0.001
< 40	453	30.4	1035	69.6	
40–49	1412	30.6	3204	69.4	
50–59	2359	42.8	3157	57.2	
60–69	3151	61.7	1960	38.3	
70–79	2899	85.8	480	14.2	
≥ 80	1835	96.5	66	3.5	
Race/ethnicity					< 0.001
White	7610	52.4	6926	47.6	
Black	1332	59.9	891	40.1	
Hispanic	943	58.6	665	41.4	
Other/unknown	2224	61.0	1420	39.0	
Income status					< 0.001
Low (< $39,000)	3136	69.8	1358	30.2	
Medium low ($39,000–$47,999)	3091	63.9	1745	36.1	
Medium high ($48,000–$62,999)	3132	54.0	2663	46.0	
High ($63,000 +)	2551	39.2	3953	60.8	
Unknown	199	52.1	183	47.9	
Insurance status					<0.001
Medicare	6158	82.1	1347	17.9	
Medicaid	1345	66.3	685	33.7	
Private	4141	35.5	7523	64.5	
Self-pay	164	68.0	77	32.0	
Other/unknown	301	52.7	270	47.3	
Type of admission					< 0.001
Urgent	1081	69.8	468	30.2	
Elective	9131	54.0	7773	46.0	
Unknown	1897	53.3	1661	46.7	
Comorbidity					< 0.001
0	3569	42.2	4887	57.8	
1	3527	55.7	2809	44.3	
≥ 2	5013	69.4	2206	30.6	

TABLE 1 continued

	Immediate breast reconstruction				*P* value
	No		Yes		
	n	%	*n*	%	
Hospital region					< 0.001
Northeast	971	48.0	1052	52.0	
Midwest	3206	58.3	2292	41.7	
South	4889	55.4	3930	44.6	
West	3043	53.7	2628	46.3	
Hospital teaching status					< 0.001
Non-teaching	6473	63.3	3753	36.7	
Teaching	5430	47.4	6027	52.6	
Unknown	206	62.8	122	37.2	
Hospital bed size					< 0.001
Small	1782	59.1	1234	40.9	
Medium	3048	59.0	2115	41.0	
Large	7073	52.4	6431	47.6	
Unknown	206	62.8	122	37.2	
Hospital location					< 0.001
Rural	1511	89.1	184	10.9	
Urban	10,392	52.0	9596	48.0	
Unknown	206	62.8	122	37.2	
HHI[a]					< 0.001
> 2500 (non-competitive)	6239	65.5	3291	34.5	
1500–2500 (moderately competitive)	2230	51.0	2143	49.0	
< 1500 (highly competitive)	3352	43.6	4331	56.4	
Unknown	288	67.8	137	32.2	

DCIS ductal carcinoma in situ, *HHI* Herfindahl–Hirschman Index

[a]Based on radius 75% definition of HHI

DISCUSSION

The data suggest that the regional market structure in which a hospital operates is associated with the likelihood of immediate breast reconstruction for women who undergo mastectomy. Although only one third of women who underwent surgery in non-competitive markets received immediate reconstruction, the rate was higher than 50% at centers operating in more competitive regional markets. The effect of market competition on access to reconstruction was independent of other clinical and demographic characteristics.

The competitive regional market in which a hospital operates appears to be an important influence on the allocation of care.[9–11,19,20] We previously demonstrated that patients undergoing urologic and gynecologic surgery at a hospital in a competitive market were approximately two to five times more likely to undergo a robotically assisted operation than those treated at hospitals in non-competitive markets. Similarly, use of endovascular surgery for aortic aneurysm repair and laparoscopy for colectomy were more common at hospitals in competitive regional markets.[10,11]

Although market competition appears to be associated with the use of procedures and interventions, the relationship between market competition and quality of care has been inconsistent. Whereas one report found that increased market competition was associated with decreased mortality for common medical conditions,[21] other studies have suggested that the influence of hospital competition on quality of care is minimal.[22,23]

Prior studies examining the influence of market competition on hospital services have predominantly explored the use of novel technologies and devices.[9,11,19,24] Hospitals operating in competitive regional markets are more likely to offer technologically advanced treatments that often are of questionable benefit, a phenomenon that coined the term "medical arms race."[24–26] Provision of these services is likely geared toward marketing with an aim to

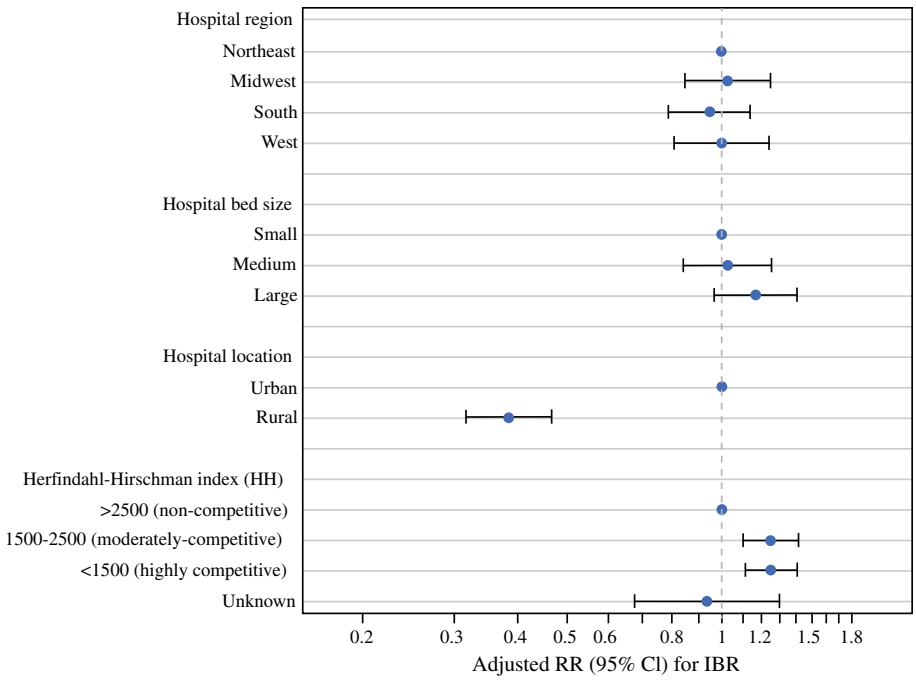

FIG. 2 Adjusted relative risk of hospital factors associated with immediate breast reconstruction

increase market share. In contrast, our data suggest that regional competitive factors also influence the allocation of a treatment that is recommended and considered best practice. In some scenarios, market competition may promote adherence to evidence-based recommendations.[21]

Previous studies have found that a variety of clinical and demographic characteristics can influence the use of immediate reconstruction. Older age, black race, marriage, residence in a rural area, and greater medical comorbidity all have been associated with decreased likelihood of immediate breast reconstruction.[7,8,27–29] Medicaid recipients are 66% less likely to undergo breast reconstruction than women with commercial insurance.[27]

Hospital and surgeon factors also influence the performance of breast reconstruction. Similarly, Women who undergo surgery by high-volume surgeons and at high-volume hospitals are more likely to undergo breast reconstruction than women treated by low-volume surgeons and at low-volume centers.[8] Patients treated at financially distressed hospitals also are less likely to undergo immediate breast reconstruction. In one analysis women who received care at hospitals classified as under high financial distress were 20% less likely to undergo breast reconstruction than those who received care at hospitals with low or no financial distress.[12] Our findings of an association between market competition and breast reconstruction were independent of other clinical and demographic characteristics.

Although our study benefited from including a large sample of patient and hospitals, we recognize a number of important limitations. First, we relied on the Herfindahl–Hirschman Index as a surrogate for market competition. Although the HHI has been widely used as a measure of competition in evaluation of mergers and acquisitions as well as in studies of medical competition, we cannot exclude the possibility that a small number of hospitals were misclassified. We performed a number of sensitivity analyses in which the definition of a market was varied to explore the validity of our findings. Second, we lacked data on patient preferences and attitudes toward breast reconstruction. Third, although we corrected for a variety of clinical and demographic characteristics, there were undoubtedly unmeasured confounders that influenced the decision to perform immediate breast reconstruction.

Finally, although we identified an association between market competition and immediate breast reconstruction, this may have been a surrogate for a variety of other factors that could have influenced the decision to perform reconstruction. For example, differences in the number of available plastic surgeons across different markets could explain a portion of the competition-based disparity that we noted.

Given the disparities in the use of breast reconstruction, a number of initiatives have been taken to raise awareness about reconstructive options. A number of legislative initiatives have been enacted to ensure that women undergoing mastectomy have access to breast reconstruction. The Women's Health and Cancer Rights Act of 1998 requires group health plans to cover mastectomy that include coverage for reconstructive surgery.[30] In 2010, New York State passed legislation mandating that providers discuss reconstruction options with patients undergoing mastectomy. One study found that

TABLE 2 Multivariate model for predictors of receipt of immediate breast reconstruction

	aRR
HHI[a]	
> 2500 (non-competitive)	Referent
1500–2500 (moderately concentrated)	1.24 (1.10–1.41)[b]
< 1500 (highly competitive)	1.25 (1.11–1.41)[b]
Unknown	0.94 (0.68–1.30)
Breast cancer	
Invasive breast cancer	Referent
DCIS	1.20 (1.14–1.26)[c]
Mastectomy	
Simple	Referent
Radical	1.14 (0.97–1.33)
Skin-sparing	1.49 (1.41–1.58)[b]
Axillary lymph node evaluation	
No	Referent
Yes	0.87 (0.83–0.91)[b]
Year	
2010	Referent
2011	1.09 (1.02–1.16)[b]
Age (years)	
< 40	Referent
40–49	0.99 (0.92–1.06)
50–59	0.87 (0.81–0.94)[b]
60–69	0.71 (0.66–0.77)[b]
70–79	0.35 (0.31–0.40)[b]
≥ 80	0.09 (0.07–0.12)[b]
Race/ethnicity	
White	Referent
Black	0.87 (0.80–0.93)[b]
Hispanic	0.91 (0.83–0.99)[b]
Other/unknown	0.83 (0.77–0.90)[b]
Income status	
Low (< $39,000)	Referent
Medium low ($39,000–$47,999)	1.08 (0.999–1.16)
Medium high ($48,000–$62,999)	1.10 (1.03–1.18)[b]
High ($63,000 +)	1.20 (1.12–1.30)[b]
Unknown	1.22 (1.04–1.44)[b]
Insurance status	
Private	Referent
Medicare	0.74 (0.68–0.80)[b]
Medicaid	0.71 (0.65–0.77)[b]
Self-pay	0.64 (0.50–0.81)[b]
Other/unknown	0.87 (0.76–0.98)[b]
Type of admission	
Elective	Referent
Urgent	0.85 (0.76–0.95)[b]
Unknown	0.81 (0.67–0.96)[b]
Comorbidity	
0	Referent
1	0.97 (0.93–1.02)
≥ 2	0.88 (0.84–0.93)[b]
Hospital region	
Northeast	Referent
Midwest	1.03 (0.85–1.25)
South	0.95 (0.79–1.14)
West	1.00 (0.81–1.24)
Hospital bed size	
Small	Referent
Medium	1.03 (0.84–1.26)
Large	1.17 (0.97–1.41)
Hospital location	
Urban	Referent
Rural	0.38 (0.32–0.47)[b]

aRR adjusted risk ratio, *HHI* Herfindahl–Hirschman Index, *DCIS* ductal carcinoma in situ

Mixed-effect log-Poisson model included breast cancer, mastectomy, axillary lymph node dissection (ALND), year, age, race, income status, insurance status, type of admission, comorbidity, hospital region, hospital bed size, hospital location, and radius 75% HHI. Hospital identifier was included as a random effect. Patients with unknown hospital teaching status, bed size, and location were not included due to multicollinearity. Hospital teaching status was not included due to a model convergence issue

[a]Based on radius 75% definition of HHI

[b]P value < 0.05

reconstruction rates in New York state increased after implementation of this legislation, particularly among minority patients and women with lower socioeconomic status.[31]

These data highlight the importance of contextual factors in the performance of immediate breast reconstruction for women undergoing mastectomy. Although competitive market forces are unlikely to change, these findings suggest that a greater understanding of why women receiving care in non-competitive markets are less likely to undergo reconstruction is needed. One plausible explanation is that access to reconstructive surgeons or hospitals that perform reconstruction is limited in non-competitive market regions. A number of studies have shown that the rate of immediate breast reconstruction is correlated with the density of plastic surgeons in a given geographic region.[32–34] Furthermore, rural regions and areas with a higher percentage of older patients have a lower concentration of plastic surgeons, which may exacerbate racial and socioeconomic disparities in breast reconstruction.[32,34]

Increasing the availability of plastic surgeons, or alternatively, selective referral of patients to other centers may improve the use of reconstruction in this scenario.

Alternatively, hospitals and surgeons in non-competitive regions may preferentially prioritize other more profitable procedures when they face no competitive pressure to offer breast reconstructive surgery. In this scenario, programs and policies to promote reconstruction targeted toward patients, providers, and hospitals may help to raise awareness. Similarly, increasing reimbursements for breast reconstruction or linking reimbursement for mastectomy to reconstruction may help to increase access to breast reconstruction.[12]

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